WHAT IS CLAIMED IS:

1. A method for estimating a displacement of a second image acquired by a sensing device relative to a first image acquired by the sensing device, the method comprising:

determining a set of correlation function value points indicative of a correlation function extremum, each correlation function value point based at least partially on a pattern of image values included in both the first image and the second image, each correlation function value point further based on a respective known spatial translation of the image values in the second image relative to the image values in the first image; and

estimating at least one spatial translation position corresponding to at least one symmetry point which is not the correlation function extremum, based on a plurality of correlation function value points bounding the correlation function extremum, the at least one spatial translation position corresponding to the at least one symmetry point indicative of the displacement of the second image relative to the first image.

2. The method of claim 1, wherein the plurality of correlation function value points bounding the correlation function extremum excludes at least one correlation function value point which lies at a spatial offset bounded by other members of the plurality of correlation function value points.

3. The method of claim 2, wherein the excluded at least one correlation function value point comprises the correlation function value point which is nearest to the correlation function extremum.

4. The method of claim 2, wherein the excluded at least one correlation function value point comprises each correlation function value point which is within a prescribed range of spatial offsets from the correlation function extremum.

5. The method of claim 2, wherein the excluded at least one correlation function value point comprises each correlation function value point which is within a prescribed range of correlation function values.

6. The method of claim 1, wherein determining the correlation function value points comprises determining a difference between paired image values, the paired image values comprising an image value included in the first image and a

corresponding image value included in the second image, and summing absolute values of the differences between the paired image values for a set of paired image values.

7. The method of claim 1, wherein estimating the spatial translation position corresponding to the at least one symmetry point comprises:

estimating a first estimate of the spatial translation position corresponding to the at least one symmetry point including predictable systematic estimation errors related to the asymmetry of the correlation function value points; and

adjusting the first estimate of the spatial translation position corresponding to the at least one symmetry point, based at least partially on the predictable systematic estimation errors, to at least partially reject predictable systematic estimation errors related to the asymmetry of the correlation function value points about the correlation function extremum.

8. The method of claim 1, wherein estimating the spatial translation position corresponding to the at least one symmetry point comprises:

determining the midpoint of at least one line segment having a first endpoint presumably lying on the correlation function on a first side of the correlation function extremum, and a second endpoint presumably lying on the correlation function on the second side of the correlation function extremum.

9. The method of claim 8, wherein at least one endpoint of the at least one line segment comprises a correlation function value point.

10. The method of claim 9, wherein each endpoint comprises a correlation function value point and estimating the spatial translation position corresponding to the at least one symmetry point further comprises:

determining a line containing the midpoint of the at least one line segment, the line having a slope corresponding to the slope between the first end point of the at least one line segment and an adjacent correlation function value point lying on the same side of the correlation extremum; and

determining a point on the line which has a y-coordinate value equal to the correlation function value of the second end point of the at least one line segment, wherein that point is taken as the symmetry point.

11. The method of claim 1, wherein estimating the spatial translation position corresponding to the at least one symmetry point comprises:

determining a first spatial translation position of a first point presumably lying on the correlation function on a first side of the correlation function extremum; and

determining a second spatial translation position which corresponds to the spatial translation position of a point presumably lying on the correlation function on the second side of the correlation function extremum, at a correlation value equal to the correlation value of the first point; and

determining the spatial translation position value which is midway between the first spatial translation position and the second spatial translation position.

12. The method of claim 11, wherein the first point comprises a correlation function value point.

13. The method of claim 12, wherein the point presumably lying on the correlation function on the second side of the correlation function extremum comprises an estimated point.

14. The method of claim 13, wherein the estimated point comprises a point lying on an estimated line segment which is estimated to correspond to the correlation function in the vicinity of the line segment.

15. The method of claim 1, wherein estimating the spatial translation position corresponding to the at least one symmetry point comprises:

determining a characterization of at least one line segment presumably corresponding to the correlation function on a first side of the correlation function extremum; and

estimating the spatial translation position corresponding to the at least one symmetry point based at least partially on the characterization of the at least one line segment and at least one characteristic of at least one correlation function value point on the second side of the correlation function extremum.

16. The method of claim 15, wherein the characterization corresponds to a prescribed form for the at least one line segment.

17. The method of claim 16, wherein the prescribed form corresponds to a line of constant curvature.

18. The method of claim 17, wherein the prescribed form corresponds to a straight line.

19. The method of claim 16, wherein the prescribed form is based on characteristics of a predetermined correlation function resulting from representative first and second images.

20. The method of claim 1, wherein estimating the spatial translation position corresponding to the at least one symmetry point comprises:

determining at least one characteristic of at least one first-side line segment based on at least two first-side correlation function value points on a first side of the correlation function extremum; and

determining at least one characteristic of at least one second-side line segment based on at least two second-side correlation function value points on a second side of the correlation function extremum; and

estimating the spatial translation position corresponding to the at least one symmetry point based on the at least one characteristic of the at least one first-side line segment and the at least one characteristic of the at least one second-side line segment.

21. The method of claim 20, wherein the at least one characteristic of each line segment comprises a slope.

22. A method for estimating a displacement of a second image acquired by a sensing device relative to a first image acquired by the sensing device, the method comprising:

determining a set of correlation function value points indicative of a correlation function extremum, each correlation function value point based at least partially on a pattern of image values included in both the first image and the second image, each correlation function value point further based on a respective known spatial translation of the image values in the second image relative to the image values in the first image; and

estimating a spatial translation position based on a plurality of correlation function value points bounding the correlation function extremum, the

spatial translation position representing the displacement of the second image relative to the first image;

wherein estimating the spatial translation position does not depend on characterizing the correlation function in the vicinity of the correlation function extremum.

23. The method of claim 22, wherein the plurality of correlation function value points bounding the correlation function extremum excludes at least one correlation function value point which lies at a spatial translation position bounded by other members of the plurality of correlation function value points.

24. The method of claim 22, wherein estimating the spatial translation position comprises estimating the correlation function curve over at least one range comprising spatial translation position values outside the vicinity of the correlation function extremum, and estimating the spatial translation position based on at least one characteristic of the estimated correlation function curve which is not local to the vicinity of the correlation function extremum.

25. The method of claim 24, wherein estimating the correlation function curve over at least one range comprising spatial translation position values outside the vicinity of the correlation function extremum encompasses estimating the correlation function curve at spatial translation position values in the vicinity of the correlation function extremum.

26. The method of claim 22, wherein estimating the spatial translation position based on a plurality of correlation function value points comprises determining a characteristic, based on the plurality of correlation function value points, which is not local to the vicinity of the correlation function extremum.

27. The method of claim 26, wherein the plurality of correlation function value points bounding the correlation function extremum excludes at least one correlation function value point which lies at a spatial translation position bounded by other members of the plurality of correlation function value points, and the characteristic based on the plurality of correlation function value points which is not local to the vicinity of the correlation function extremum is the location of a presumed line of symmetry.

28. The method of claim 22, wherein the plurality of correlation function value points comprises less than 10 correlation function value points.

29. The method of claim 28, wherein the plurality of correlation function value points comprises less than 6 correlation function value points.

30. The method of claim 22, wherein estimating the spatial translation position comprises:

estimating a first estimate of the spatial translation position including predictable systematic estimation errors related to the asymmetry of the correlation function value points about the correlation function extremum; and

adjusting the first estimate of the spatial translation position, based at least partially on the predictable systematic estimation errors, to at least partially reject predictable systematic estimation errors related to the asymmetry of the correlation function value points about the correlation function extremum.

31. The method of claim 22, wherein the displacement of the second image relative to the first image is indicative of movement of a surface which moves relative to the sensing device.

32. The method of claim 22, wherein the first and second images comprise a speckle pattern.

33. An image-correlation optical position transducer readhead, usable to measure displacement relative to a member having an image-determining surface, the readhead comprising:

a sensing device that receives light reflected from the image-determining surface, the sensing device comprising a plurality of image elements that are sensitive to the reflected light, the plurality of image elements being spaced apart along at least a first direction, the image elements spaced along the first direction at a predetermined spacing, the predetermined spacing usable to determine the spatial translation of an image on the readhead, the spatial translation of the image on the readhead usable to determine the relative displacement of the readhead and the image-determining surface along a predetermined direction,

a light detector interface circuit connected to the sensing device, the light detector interface circuitry outputting signal values from the image elements of the sensing device, the signal values representative of image intensities of the

reflected light on those image elements, and

a signal generating and processing circuitry element connected to the light detector interface circuit;

wherein:

the light reflected from the image-determining surface creates an intensity pattern on the plurality of image elements based on the relative position of the image-determining surface and the readhead;

the light detector interface circuitry outputs a signal value from at least some of the plurality of image elements, the signal values together comprising an image;

the signal generating and processing circuitry element inputs a first image corresponding to a first relative position of the image-determining surface and the readhead and stores a representation of the image;

the signal generating and processing circuitry element inputs a second image corresponding to a second relative position of the image-determining surface and the readhead;

the signal generating and processing circuitry element, based on the first and second images, determines a set of correlation function value points indicative of a correlation function extremum; and

the signal generating and processing circuitry element estimates a spatial translation position based on a plurality of correlation function value points bounding the correlation function extremum, the spatial translation position representing the displacement of the second image relative to the first image;

wherein estimating the spatial translation position does not depend on characterizing the correlation function in the vicinity of the correlation function extremum.

34. The readhead of claim 33, wherein the signal generating and processing circuitry element determines a relative displacement between the image-determining surface and the read head along at least one axis, based on the spatial translation position.

35. The readhead of claim 33, wherein the image-correlation optical position transducer readhead is a speckle-image correlation optical position transducer

readhead, the image-determining surface is an optically diffusing surface, and the light reflected from the image-determining surface is generated from a coherent light source.

36. The readhead of claim 33, wherein the signal generating and processing circuitry element comprises a processor and an associated program.

37. The readhead of claim 33, wherein the signal generating and processing circuitry element comprises an interpolation circuit.

38. The readhead of claim 37, wherein the interpolation circuit comprises:

a correlation function value point identification circuit;

an estimated coordinate identification circuit; and

an estimated peak offset value determining circuit.

39. The readhead of claim 38, wherein:

the correlation function value point identification circuit selects the plurality of correlation function value points bounding the correlation function extremum;

the estimated coordinate identification circuit characterizes at least the spatial translation position value corresponding to at least one point which is not one of the plurality of selected correlation function value points; and

the estimated peak offset value determining circuit estimates the spatial translation position representing the displacement of the second image relative to the first image, at least partially based on the characterization corresponding to at least one point which is not one of the plurality of selected correlation function value points.

40. The readhead of claim 39, wherein:

the at least one point which is not one of the plurality of selected correlation function value points comprises an estimated point presumed to lie on the correlation function on the opposite side of the correlation function extremum from a particular one of the plurality of correlation function value points, the estimated point having the same correlation function value coordinate as the particular one of the plurality of correlation function value points; and

the estimated peak offset value determining circuit estimates the spatial translation position representing the displacement of the second image relative to the

first image based on the characterization corresponding to the estimated point, and at least the spatial translation position of the particular one of the plurality of correlation function value points.

41. A speckle-image-correlation optical position transducer readhead, usable to measure displacement relative to a member having an optically diffusing surface, the readhead comprising:

a sensing device that receives the light scattered from a portion of the optically diffusing surface illuminated with coherent light, the sensing device comprising a plurality of image elements that are sensitive to the scattered light, the plurality of image elements being spaced apart along at least a first direction at a predetermined pitch,

a light detector interface circuit connected to the sensing device, the light detector interface circuitry outputting signal values from the image elements of the sensing device, the signal values representative of image intensities of the scattered light on those image elements, and

a signal generating and processing circuitry element connected to the light detector interface circuit;

wherein:

the light detector interface circuitry outputs a signal value from at least some of the plurality of image elements, the signal values together comprising an image;

the signal generating and processing circuitry element inputs a first image corresponding to a first relative position of the optically diffusing surface and the readhead and stores a representation of the image;

the signal generating and processing circuitry element inputs a second image corresponding to a second relative position of the optically diffusing surface and the readhead;

the signal generating and processing circuitry element, based on the first and second images, estimates a first plurality of correlation function value points indicative of a correlation function extremum;

the signal generating and processing circuitry element, based on a set of correlation function value comprising at least some of the plurality of correlation

function value points, estimates a spatial translation position representing the displacement of the second image relative to the first image; and

wherein, for the speckle-image-correlation optical position transducer readhead, the ratio of the peak-to-peak systematic error which repeats at a period corresponding to one image element pitch to the number of correlation function value points in the set used to determine the spatial translation position is not more than about .02 parts of the image element pitch per correlation function value point, when the peak-to-peak systematic error is expressed as a fraction of the image element pitch.

42. The speckle-image-correlation optical position transducer readhead of claim 41, wherein the ratio is not more than about .01 parts of the image element pitch per correlation function value point.

43. The speckle-image-correlation optical position transducer readhead of claim 41, wherein the ratio is not more than about .005 parts of the image element pitch per correlation function value point.